MERRIMACK RIVER BASIN
MANCHESTER, NEW HAMPSHIRE

GOFFS FALLS DAM

NH 00292

NHWRB 150.05

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1980

UNCLASSIFIED

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Merrimack River Basin
Manchester, New Hampshire
Cohas Brook, tributary of the Merrimack River

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The dam is a gravity structure constructed of split masonry. It is about 80 ft. long and 17 ft. high. The dam is small in size with a significant hazard potential. THe dam is in poor condition at the present time. There are remedial measures and studies which should be implemented by the owner as soom as possoble.

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NATIONAL DAM INSPECTION

PHASE I INSPECTION REPORT

Identification No.:	NH 00292
NHWRB No.:	150.05
Name of Dam:	Goffs Falls Dam
Town:	Manchester
County and State:	Hillsboro, New Hampshire
Stream:	Cohas Brook, a tributary of the Merrimack River
Date of Inspection:	April 28, 1980

BRIEF ASSESSMENT

Goffs Falls Dam is located on Cohas Brook approximately 0.4 miles upstream of its confluence with the Merrimack River. New Hampshire State Route 3A crosses Cohas Brook approximately 300 feet downstream of the dam.

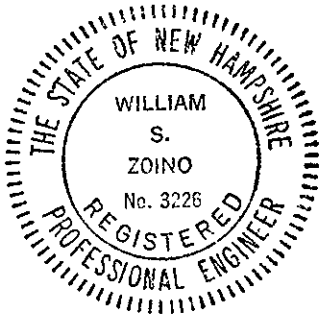
The dam is a gravity structure constructed of split stone masonry. It is approximately 80 feet long and 17 feet high. The overflow type spillway has a crest length of 68.5 feet and is 12 feet above the streambed. There is an abandoned sluiceway approximately 10 feet wide at the left end of the spillway. This has been filled in with debris and rubble fill to a level slightly higher than the overflow spillway.

The dam was built in 1896 to provide power for a woolens mill. Since then it has been known as the Devonshire Mills Dam No. 2, Waterman Worcester Co. Dam No. 2, and Pine Island Park Dam. In 1952, approval was granted to the New Pine Island Park Inc. to undertake repair of the dam. No records of these repairs exist. The dam is presently owned by the estate of Mr. Lawrence Desrosier of Manchester, New Hampshire.

The drainage area for this dam consists of approximately 65 square miles of rolling terrain which is moderately developed and includes Massabesic Lake and the Manchester Airport. The dam is SMALL in size and its hazard potential classification is SIGNIFICANT since appreciable economic loss and possible loss of a few lives could result in the event of dam failure. The appropriate Test Flood for a dam classified SMALL in size with a SIGNIFICANT hazard potential would be between the 100-year flood and one-half the Probable Maximum Flood (PMF). Since the risk downstream in the event of dam failure is on the low side of SIGNIFICANT, the 100-year flood has been adopted as the appropriate Test Flood.

The analysis in Appendix D shows a peak 100-year inflow of 3,600 cfs for the dam. Attenuation due to storage in the reservoir is negligible and the Test Flood routed peak outflow is 3,600 cfs, with the water surface at 154.7 feet (NGVD), which is 6.1 feet above the principal spillway. The spillway is capable of passing 63% of the Test Flood routed peak outflow.

The dam is in POOR condition at the present time. It is recommended that the owner retain the services of a qualified registered professional engineer to evaluate the condition of the abandoned sluiceway and undermined right end wall, and make recommendations for the rehabilitation of these structures. Remedial measures to be undertaken by the owner include clearing of debris and brush from the spillway and downstream channel, implementing annual maintenance and inspection programs, and developing a formal written system for warning downstream residents and officials in the event of an emergency. These engineering studies and remedial measures should be implemented by the owner within 1 year of receipt of this Phase I Inspection Report.



William S Zoino

William S. Zoino
NH Registration No. 3226

Nicholas A. Campagna, Jr.
California Registration No. 21006

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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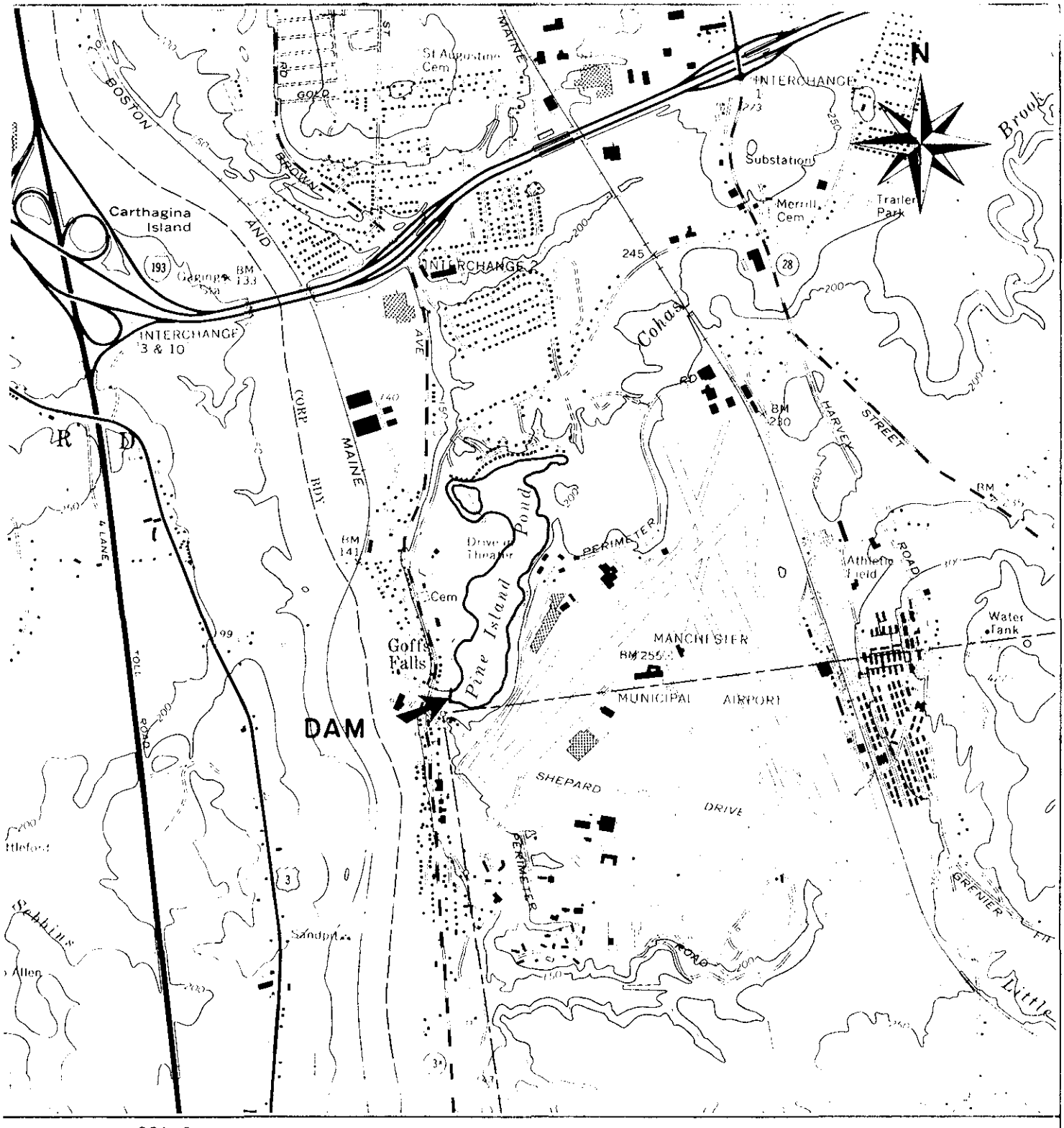
APPENDICES

Overview of Dam



- SCALE -
0 1000 2000 4000 (FEET)

FROM: USGS MANCHESTER SOUTH - N.H., QUADRANGLE MAP

GOLDBERG · ZOINO & ASSOCIATES, INC. GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION PLAN

FILE No. 2605

GOFFSFALLS DAM — MANCHESTER, NEW HAMPSHIRE

			SCALE AS SHOWN
			DATE

National Dam Inspection Program

Phase I Inspection Report

Goffs Falls Dam

Section I: Project Information

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Progam of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg-Zoino & Associates, Inc. (GZA) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to GZA under a letter of April 17, 1980 from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract NO. DACW 33-80-C-0055 has been assigned by the Corps of Engineers for this work.

(b) Purpose

1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

3) Update, verify, and complete the National Inventory of Dams.

1.2 Description of Dam

(a) Location

The Goffs Falls Dam is located on Cohas Brook in Manchester, New Hampshire approximately 850 feet upstream of its confluence with the Merrimack River. It can be reached from State Route 3A in Manchester which crosses Cohas Brook approximately 300 feet downstream of the dam. The dam is shown on USGS Manchester quadrangle at approximate coordinates N4255.9, W7127.1 (see location map on Page vi).

(b) Description of Dam and Appurtenances

The dam is a gravity structure of split stone masonry. It is a total of 80 feet long and 17 feet high with an abandoned sluiceway at the left abutment. See sketch of site on page D-11.

1) Right Abutment

The right abutment extends 4.5 feet (elevation 153.1 feet NGVD) above the spillway crest, and is considered to be the top of the dam. There is a split stone masonry end wall which extends downstream of the dam as far as the route 3A bridge.

2) Spillway

The spillway is a broad crested weir of split stone masonry construction with a weir length of 68.5 feet. The spillway has been equipped with up to 3.5 feet of flashboards in the past but none are in place at present. The crest elevation is approximately 148.6 feet (NGVD).

3) Sluiceway

At the left end of the spillway are the remains of a 10 foot wide sluiceway which once formed the head race and tail race of a woolens mill. The mill building has been torn down and the sluiceway and gate sections have rotted out, and collapsed. The sluiceway is filled with rubble and debris, and stone has been placed to divert flow over the spillway.

4) Left Abutment

The left abutment extends 7 feet (elevation 155.6 feet NGVD) above the spillway crest with a stone masonry end wall which extends up and downstream of the dam.

(c) Size Classification

The dam's maximum impoundment of 310 acre feet and height of 17 feet place it in the SMALL size category according to the Corps of Engineer's Recommended Guidelines.

(d) Hazard Potential Classification

The hazard potential classification for this dam is SIGNIFICANT because of the appreciable economic losses and potential for loss of a few lives downstream in the event of dam failure. Section 5 of this report presents more detailed discussion of the hazard potential.

(e) Ownership

The dam is presently owned by the Estate of Mr. Lawrence Desrosier, deceased, of Manchester, New Hampshire. The Administrator of the Estate is Mr. Victor Dahar, Attorney, 814 Elm Street, Manchester, New Hampshire. He can be reached by telephone at (603) 622-6595 or (603) 669-0134.

(f) Operator

The operation of the dam is controlled by Mr. Victor Dahar, Attorney, of Manchester, New Hampshire. Mr. Dahar can be reached by telephone at (603) 622-6595 or (603) 669-0134.

(g) Purpose of the Dam

The purpose of the dam is to impound water for recreational purposes. At one time, the dam was used for hydropower for a woolens mill.

(h) Design and Construction History

The original design and date of construction are unknown. The records of the New Hampshire Water Resources Board indicate that the dam was constructed in 1896 with a mill building at the left abutment and a split stone masonry spillway constructed on earth. As of 1936, this mill had been abandoned and by 1948, the dam was not impounding water. In 1952, a civic group was given permission to repair the dam but no records of repair are available.

(i) Normal Operating Procedure

No formal operating procedures exist for this dam. There are no outlet works at the site, and no means available to lower the impoundment.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 65 square miles. It is made up of approximately 50 percent development and 50 percent rolling woodland and pasture.

(b) Discharge at Dam Site

1) Outlet Works

There are no outlet works at this dam site.

2) Maximum Known Flood

There is no data available for the Maximum Known Flood at this dam site. The maximum discharge at Lake Massabesic, which is approximately 4 miles upstream of the dam, occurred in March 1936. The discharge at that site was 2,230 cfs.

3) Ungated Spillway Capacity at Top of Dam

The capacity of the spillway with the reservoir at top of dam elevation (153.1 feet NGVD) is 2,800 cfs.

4) Ungated Spillway Capacity at Test Flood

The test flood overtops the dam by 1.6 feet. The capacity of the spillway section at this elevation (154.7 NGVD) is 3,570 cfs.

5) Gated Spillway Capacity at Normal Pool

There are no gated spillways.

6) Gated Spillway Capacity at Test Flood

There are no gated spillways.

7) Total Spillway Capacity at Test Flood

The Test Flood overtops the dam by 1.6 feet. The spillway section passes 3,570 cfs at this elevation. (154.7 feet NGVD)

8) Total Project Discharge at Top of Dam

The total project discharge at top of dam elevation (153.1 feet NGVD) is 2,280 cfs.

9) Total Project Discharge at Test Flood Elevation

The total project discharge at Test Flood elevation (154.7 feet NGVD) is 3,600 cfs.

(c) Elevation (feet above NGVD)

1) Streambed at toe of dam: approximately 136.1

2) Bottom of cutoff: unknown

3) Maximum tailwater: unknown

4) Recreation Pool: Approximately 148.6

5) Full flood control pool: Not applicable

6) Spillway crest: Approximately 148.6

7) Design surcharge: Unknown

8) Top of dam: 153.1

9) Test flood surcharge: 154.7

(d) Reservior (length in feet)

1) Normal Pool: 4000

2) Flood Control Pool: Not applicable

3) Spillway Crest: 4000

4) Test Flood Pool: 4000

5) Top of Dam: 4000

(e) Storage (acre-feet)

1) Normal Pool: 150

2) Flood Control Pool: Not applicable

3) Spillway Crest Pool: 150

4) Top of Dam Pool: 310

5) Test Flood Pool: 376

(f) Reservoir Surface (acres)

1) Normal Pool: 37

2) Flood Control Pool: Not applicable

3) Spillway Crest: 37

4) Test Flood Pool: 37

5) Top of Dam: 37

(g) Dam

1) Type: Gravity, overflow, split stone masonry

2) Length: Approximately 80 feet

3) Height: Approximately 16.5 feet

4) Top width: Approximately 5 feet

5) Side slopes: Not applicable

6) Zoning: Not applicable.

7) Impervious Core: Not applicable

8) Cutoff: Unknown

9) Grout curtain: Unknown

(h) Diversion and Regulating Tunnel

Not applicable

(i) Spillway

1) Type: Masonry, broad crest weir

2) Length of weir: 68.5

3) Crest elevation: 148.6 feet (NGVD)

4) Gates: Spillway not equipped with gates

5) Upstream channel: Reservoir

6) Downstream channel: Cohas Brook, rocky, shallow gradient

(j) Regulating Outlets

There are no regulating outlets at this dam. A former sluiceway on the left abutment has been blocked, and abandoned.

Section 2: Engineering Data

2.1 Design Data

None of the original design drawings or calculations are available for this dam. Lacking is data concerning the length and depth of any cutoff and the foundation conditions.

2.2 Construction Records

No construction records are available for this dam.

2.3 Operational Records

No operational records are available for this dam.

2.4 Evaluation of Data

a) Availability

There is no detailed design or construction data available for evaluation.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment of the dam is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the records of the New Hampshire Water Resources Board, a satisfactory evaluation for validity is indicated.

Section 3: Visual Inspection

3.1 Findings

(a) General

The Goffs Falls Dam is in POOR condition at the present time.

(b) Dam

(1) Spillway (See Photo 1 and overview)

This split stone masonry structure is in good condition without any evidence of stone displacement or settling. The spillway was observed during low flow conditions on October 10, 1980, and no evidence of seepage was observed.

(2) Sluiceway (See Photos 2 and 3)

This sluiceway which is located immediately to the left of the spillway has been abandoned and is in deteriorated condition. The opening of this structure is partially filled with earth, rotted timbers, the remains of timber sluice gate stems, and a broken metal gate. Small hand stones have been placed at the interface with the sluiceway in order to divert the flow over spillway. These stones are in the range of 6 to 8 inches in height with considerable voids throughout its length.

(3) Right End Wall (See Photo 1)

The upstream portion of the dry, split stone, masonry structure is in good condition. However, the downstream portion of this structure exhibits a void approximately 5 feet square. A sink hole was observed on the right bank immediately above this void. This hole was approximately 2 to 3 feet in diameter at the surface and is the result of fine material being washed out through the void in the wall below.

(4) Left End Wall (See Photo 3)

The dry, split stone, masonry wall is in fair condition with the exception of the displacement of stone at the downstream end of the abandoned sluiceway. The upstream extension and the return into the left bank are in good condition. Visual observations also revealed the upstream portion of this wall lacks continuity. Large trees are flourishing at this location.

(c) Reservoir Area (See overview photo)

The shore of the reservior area is generally shallow to medium sloping woodland. It appears to be stable and in good condition.

(d) Downstream Channel (See Photos 4 and 5)

The downstream channel is the Cohas Brook channel. It appears to be stable and in good condition. There is accumulation of debris in this channel which should be cleared.

3.2 Evaluation

The dam and its appurtenant structures are generally in poor condition. The problem areas noted during the visual inspection are listed as follows:

a) The abandoned sluiceway is in need of rehabilitation as its condition threatens the stability of the left abutment. If the sluiceway cannot provide adequate drawdown capability, a low level outlet should be considered.

b) The right end wall has a large void at the base.

c) The spillway and downstream channel need clearing of debris.

d) There is no means available to lower the impoundment in the event of an emergency.

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No written operational procedures exist for this dam. The dam is normally self regulating. There are no outlet works for this dam.

(b) Description of Any Warning System in Effect

There is no warning system in effect at this dam.

4.2 Maintenance Procedures

(a) General

No formal maintenance program exists for the dam, and maintenance is performed infrequently.

(b) Operating Facilities

No formal maintenance program exists, and maintenance is performed infrequently.

4.3 Evaluation

Emphasis on routine maintenance will assist the owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

Goffs Falls Dam was originally built as part of a mill in 1896 on Cohas Brook, about 850 feet upstream of the Merrimack River in Manchester, New Hampshire. It is a split stone masonry dam approximately 80 feet in length. Pine Island Pond, a 37-acre recreational pond, is formed behind this dam. This pond has been the subject of much controvery in the past 20 years because the deterioration of the sluiceway control resulted in some low water conditions.

The Cohas Brook watershed consists of rolling, mountainous terrain, and the lower reaches drain some parts of the city of Manchester. The drainage area of the watershed is 65 square miles. If the Massabesic Lake watershed is excluded, the drainage area is reduced to 17 square miles. Massabesic Lake is used as a water supply reservior for Manchester. During low flow conditions, a pumping station keeps some water flowing in Cohas Brook.

The Goffs Falls Dam spillway section is 68.5 feet in length and 5 feet long. On the left abutment, there is an old raceway structure 10 feet long and presently filled with debris to approximately the level of the spillway. The structure originally had 3.5 foot flashboards but these have been removed. The dam has a maximum impounding capacity of 310 acre-feet.

Downstream of the dam, Cohas Brook flows on a shallow gradient with steep banks that rise 12-14 feet above the streambed. About 300 feet downstream of the dam, Cohas Brook flows under Route 3A through a 35-foot wide by 12-foot high bridge opening. One house on the right bank just upstream of the bridge has a floor elevation about 14 to 16 feet above the streambed.

About 400 to 500 feet downstream of the dam are two houses on the right bank which are about 12 feet above the streambed. Further downstream are two more houses which are 14 to 16 feet above the channel. About 850 feet downstream of the dam is the confluence of Cohas Brook and the Merrimack River. Near the confluence on the left bank are the ruins of an abandoned factory.

5.2 Design Data

Data sources available for Goffs Falls dam include a survey sketch by the New Hampshire Water Resources Board dated August 13, 1937. Also available is a summary of the dam in "Inventory of Dams in the United States" by the Soil Conservation Service, as well as correspondence between the Water Resources Board and several residents.

5.3 Experience Data

No experience on flows or stages are available for Goffs Falls Dam.

5.4 Test Flood Analysis

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass. This requires use of the discharge and storage characteristics of the structure to evaluate the impact of an appropriately sized Test Flood. Some original hydraulic and hydrologic design analysis by the Soil Conservation Service was available for this dam.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guildlines" of the Corps of Engineers. The impoundment of less than 1000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is SIGNIFICANT because of the significant economic losses and small potential for loss of a few lives downstream in the event of failure of the dam.

As shown in the Dam Failure Analysis section, the increase in flooding caused by failure would probably wash out the Route 3A bridge, yet it would cause only minimal damage to one house in the reach between the dam and the Route 3A bridge.

As shown in Table 3 of the "Recommended Guidelines", the appropriate Test Flood for a dam classified SMALL in size with a SIGNIFICANT hazard potential would be between the 100-year flood and one-half the probable maximum flood (PMF). Since the risk downstream in the event of dam failure is on the low side of SIGNIFICANT, the 100-year flood has been adopted as is the appropriate Test Flood.

The analysis in Appendix D shows a peak 100-year inflow of 3,600 cfs for the dam. Attenuation due to storage in the reservoir is negligible and the Test Flood routed peak outflow is 3,600 cfs, with the water surface at 154.7 feet (NGVD), which is 6.1 feet above the principal spillway. The discharge capacity of 2,280 cfs is 63% of the peak test flood outflow of 3,600 cfs. Most of the flow in excess of the spillway capacity would continue to pass over the 68.5 foot principal spillway, but at a depth that exceeds the lower (right side) abutment height. It is estimated that only about 30 cfs of the peak test flood outflow would actually flow over this abutment.

5.5 Dam Failure Anaylsis

The peak outflow at Goffs Falls Dam that would result from dam failure is estimated using the procedure suggested in the "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." Failure is assumed to occur with the pool level at the top of the right abutment, 4.5 feet above the spillway crest. This is 17.0 feet above the natural streambed level. Just prior to failure, the normal outflow through the spillway would be 2280 cfs, with a tailwater level estimated at 11.9 feet below the headwater level. Assuming a 31.4 foot gap is opened in the dam, the peak failure outflow through this gap and over the remainder of the spillway would be 5,050 cfs.

About 300 feet downstream of the Goffs Falls Dam, Cohas Brook flows under Route 3A through a 35-foot by 12-foot bridge opening. At the peak failure flow

of 5,050 cfs, the water surface upstream of the bridge would rise about 2.6 feet above the steel beam low chord, overflowing the roadway by about 0.5 feet. In the reach between the dam and the bridge are two houses, one is high above the streambed but one on the right bank is about 14 to 16 feet above the streambed at the first floor. This house may experience minor flooding due to the bridge backwater. Downstream of the Route 3A bridge, the flood wave depth would be approximately 9.3 feet.

About 400 to 500 feet downstream of the dam are two houses which are approximately 12 feet above the failure flow elevation. Another 100 feet downstream are two more houses which are 14 to 16 feet above the streambed and are in no danger of flooding. The increased discharge entering the Merrimack River, about 3,700 cfs, would cause an insignificant rise in the larger river.

Section 6: Structural Stability

6.1 Evaluation of Structural Stability

(a) Visual Observations

1) General

The Goffs Falls dam is in poor condition at the present time.

2) Spillway

This structure is in good condition.

3) Sluiceway

This abandoned sluiceway is in poor condition.

4) Right End Wall

Stones have been dislodged the base of this wall.

5) Left End Wall

A portion of this wall appears to have been removed.

(b) Design and Construction Records

No plans or calculations of value to a stability assessment are available for this dam.

6.2 Design and Construction Data

No records of structural stability analyses are available for this dam.

6.3 Post Construction Changes

The sluiceway at the left end of the dam has been filled in with debris and rubble. This was probably accomplished in 1952 when a civic group was granted permission to repair the dam.

6.4 Seismic Stability

The dam is located in seismic zone No. 2, and, in accordance with the recommended Phase I guidelines, does not warrant seismic analysis.

Section 7: Assessment, Recommendations and Remedial Measures

7.1 Dam Assessment

(a) Condition

The Goffs Fall Dam is in POOR condition at the present time. The abandoned sluiceway should be reconstructed in order to preclude failure of the left bank and to provide a means to lower the pond level in the event of an emergency. The void in the right end wall should be repaired.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgement.

(c) Urgency

The engineering studies and improvements described herein should be implemented by the owner within one year of receipt of this Phase 1 Inspection Report.

7.2 Recommendations

It is recommended that the services of a qualified registered professional engineer be retained to evaluate the condition of the abandoned sluiceway and the undermined right end wall and sinkhole. The engineer should prepare recommendations and complete plans for rehabilitation of these structures. The owner should implement the findings of this evaluation.

7.3 Remedial Measures

It is recommended that the following remedial measures be undertaken by the owner:

(a) Clear debris from spillway and downstream channel.

(b) Implement a program of annual technical inspections of the dam and its appurtenances including operation of all outlet works.

(c) Develop a plan for surveillance of the dam during and immediately after periods of heavy rainfall and a formal downstream warning system for alerting downstream residents and officials in the event of an emergency.

(d) Implement and intensify a program of diligent and periodic maintenance.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

Inspection Team Organization

DATE: April 28, 1980

PROJECT: NH00292
Goffs Falls Dam
Manchester, New Hampshire
NHWRB 150.05

WEATHER: Cloudy, drizzle, 50

INSPECTION TEAM:

Nicholas A. Campagna	Goldberg-Zoino & Assoc.	Team Captain
William S. Zoino	GZA	Soils
Jeffrey M. Hardin	GZA	Soils
Andrew Christo	Andrew Christo Engineers	Structures
Paul Razgha	ACE	Structures
Carl Razgha	ACE	Structures
Richard Laramie	Resource Analysis, Inc.	Hydrology
Tom Gooch	RAI	Hydrology

NHWRB Representative Present - Pattu Kesavan

NOTE: Andrew Christo Engineers inspected this dam for structural condition on October 10, 1980. Resource Analysis Inc., inspected this dam for hydraulic evaluation on April 24, 1980.

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
GENERAL		
Crest Elevation	JMH	153.1 feet (NGVD)
Current Pool Elevation	JMH	148.6 feet (NGVD)
Maximum Impoundment to Date		No Data
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a. Approach Channel		
General Condition	JMH	Good
Loose Rock Overhanging Channel		None
Trees Overhanging Channel		Minor
Floor of Approach Channel	JMH	Submerged
b. Right End Wall		
General Condition of Masonry	AC	Good with the exception of a 5 to 6 foot diameter void downstream of the spillway. There is a sinkhole in the embankment above this void
Rust or Staining		Not applicable
Spalling		Not applicable
Visible Reinforcing		Not applicable
Seepage		None noted
Efflorescence		Not applicable
c. Spillway		
General Condition of Masonry	AC	Good

CHECKLIST FOR VISUAL INSPECTION

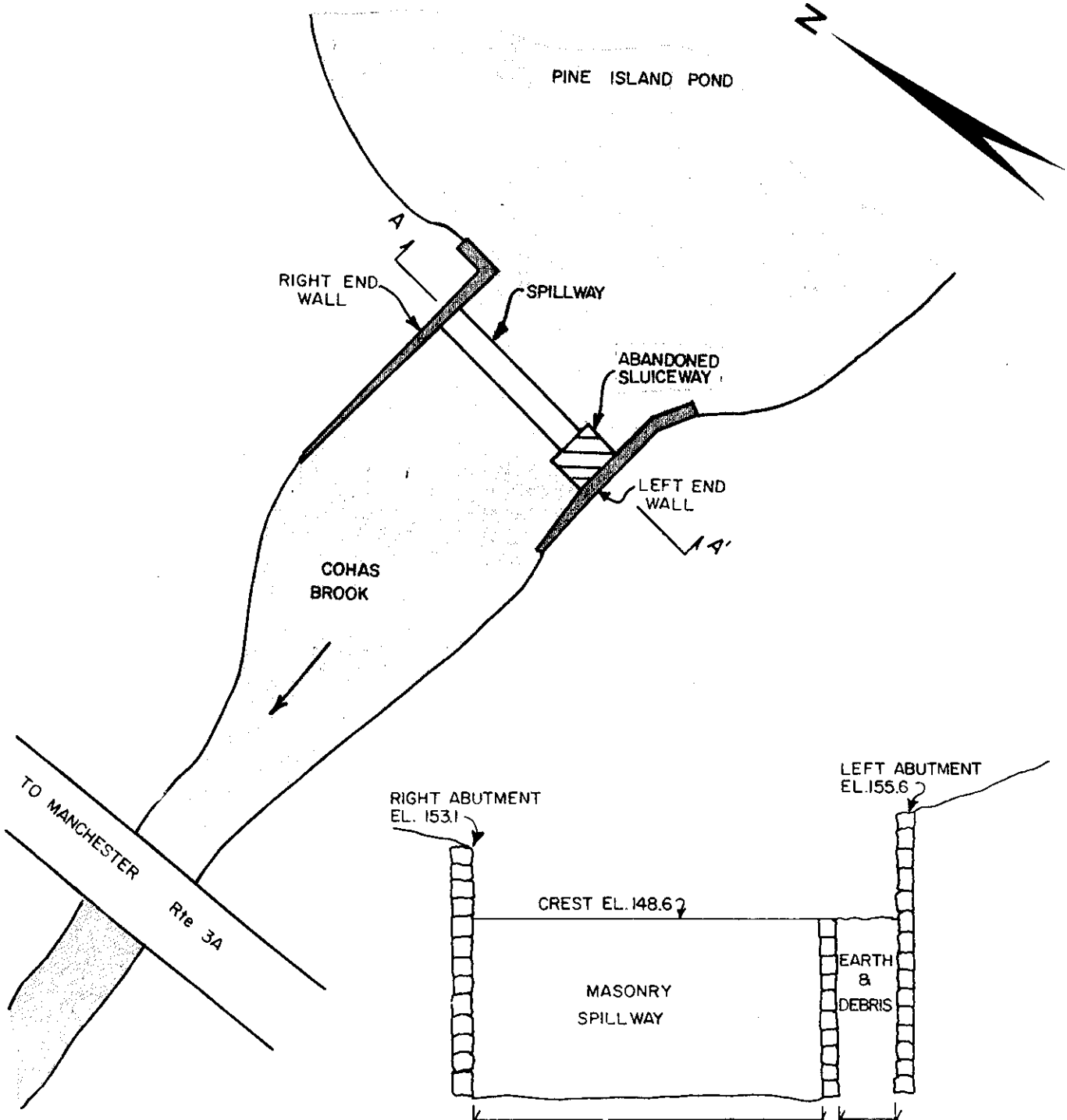
AREA EVALUATED	BY	CONDITIONS AND REMARKS
Rust or Staining	AC	Not applicable
Spalling		Not applicable
Any Visible Reinforcing		Not applicable
Any Seepage or Efflorescence		None noted
Other		Some debris at crest
d. Left End Wall		
General Condition of Masonry		Fair, some displacement downstream of sluiceway
Rust or Staining		Not applicable
Spalling		Not applicable
Visible Reinforcing		Not applicable
Seepage		None noted
Efflorescence	AC	Not applicable
e. Discharge Channel		
General Condition	JMH	Good
Loose Rock Overhanging Channel		None
Trees Overhanging Channel		Minor
Floor of Channel		Submerged
Other Obstructions	JMH	Some minor debris

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL		
General Condition	AC	Completely destroyed, randomly filled with earth, rubble, and debris
Rust or Staining		Not applicable
Spalling		Not applicable
Erosion or Cavitation		None noted
Visible Reinforcing		Not applicable
Any Seepage or Efflorescence		None noted
Condition at Joints	AC	Not applicable
Drain Holes		None noted
Channel		
Loose Rock or Trees Overhanging Channel	NAC	Minor
Condition of Discharge Channel	NAC	Good

APPENDIX B

ENGINEERING DATA



SECTION A-A'

GOLDBERG · ZOINO & ASSOCIATES, INC. GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SITE PLAN

FILE No. 2605

GOFFS FALLS DAM — MANCHESTER, NEW HAMPSHIRE

SCALE SCHEMATIC

DATE OCT. 1980

State of New Hampshire
WATER RESOURCES BOARD
37 Pleasant Street
Concord, N.H. 03301
TELEPHONE 271-3406

May 25, 1979

Mr. Paul Erickson
79 Come Street
Manchester, New Hampshire 03104

Subject: Dam No. 150.05

Dear Mr. Erickson:

Enclosed please find a copy of our laws for your reference.

Our files indicate that the present owner of the dam in the Lawrence Desrosiers Estate. In 1975 the City of Manchester through the Industrial Council showed some interest in the possibility of purchasing this structure; however, due to the extensive repairs required they declined to purchase the dam.

If I can be of any further assistance please contact me at 271-3406.

Sincerely,

Zoes Dimos,
Water Resources Engineer

ZD:paf
Enc.

The State of New Hampshire

Water Supply and Pollution Control Commission
Prescott Park
P.O. Box 95—105 Loudon Road
Concord 03301

11 May 1979

Mr. Paul Erickson
79 Come Street
Manchester, New Hampshire 03103

Subject: Pine Island Pond

Dear Mr. Erickson:

Your questions and concerns regarding the dam at Pine Island Pond should be addressed to the Water Resources Board. I have taken the liberty of sending them a copy of this, and your, letter. You should hear from them directly.

Water Sample Tests Results: 2 August 1978

The sample was taken from a natural beach, at the request of the Manchester Health Department. Total coliform bacteria was 460, not alarming from a bathing beach on Wednesday in August, when one considers all the rinsings from bodies.

Meeting to Inspect the Lake:

Mr. Kenneth Warren of this agency's Biology Division will be pleased to be accomodating. Please call 271 3503, ask for Mr. Towne, and we will arrange a time and place. This will be more timely than waiting for the mails

Very truly yours,

Ronald E. Towne

Ronald E. Towne,
Water Pollution Biologist

cc/ Water Resources Board

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant St.
CONCORD 03301

May 7, 1975

DELAROSBE?

Mr. Lawrence Desrocher
3029 Brown Avenue
Manchester, NH 03101

CERTIFIED MAIL

Dear Mr. Desrocher:

On March 14, 1974, an engineer of the New Hampshire Water Resources Board inspected your dam located on Cohas Brook in the Town of Manchester.

This dam, #150.05 in the files of the New Hampshire Water Resources Board, is classified as a non-menace structure, and as a result of our inspection, it is our finding that several items of maintenance noted on the attached sheet are in need of correction so that this dam does not become a "Dam in Disrepair".

Under the provisions of Chapter 482:42-59, by petition from the selectmen of the town or mayor of any municipality or upon its own motion, the Board may conduct a public hearing for determining whether or not said dam is a "Dam in Disrepair". Should such a finding be determined, the owner would be requested to make the repairs within a specified time period. Upon failure to do so, the town, by the provisions of these statutes, may take the dam.

If you have any questions regarding the above, please contact us at your convenience.

Very truly yours,

George M. McGee, Sr.
Chairman

gmmg/vak:js
enclosure
cc: Town Clerk

DESROCHER

Mr. Lawrence Desrocher
3029 Brown Avenue
Manchester, NH 03101

RE: REPAIRS TO BE MADE TO DAM #150.05 ON COHAS BROOK, MANCHESTER

1. Replace missing stones in right abutment.

2. Rebuild gate section.

zd/js

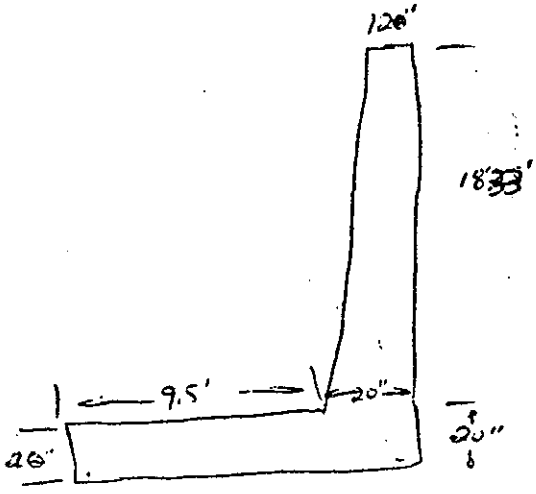
esign for Prine Island

Item #1 ⇒ Remove 30'± of Cut Stone Wall
Approx. 20' high

Item #2 ⇒ Build U shaped stop log Sect.

Item #3 ⇒ Build cutoff wall into Bank

BANK WALL ⇒



#8 bars @ 10" c to c (continuous)

Concrete ⇒ Stem: $\frac{1}{2}\left[\frac{20+12}{12}\right][18.33'][25] = 23\ yd^3$

Footing: $(11.16)(1.66)(25) = 17.2\ yd^3$

Vertical Steel.

8 Bars B-7 $\frac{12}{10}[25'] = 30$ bars - 20' long

6 Bars = 15 Bars - 20' long

300'//

#4 Bars @ (25) Bars/face

@ 25(20') + 13(20) = 760'

Horizontal Steel

#4 - 2 (20 Bars)(20') + 20 Bars (@) = 1000'

Footing ⇒ 2(500') = 600'

Training Wall

Concrete (1.25')(20')(20') = 18.5 yd³

#4 Bars → 2 [20 Bars (25')] = 1000'

#4 Bars 2 [20 Bars (25')] = 1000'

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: MANCHESTER Dam Number: 150.05

Inspected by: ZJD Date: 3-14 1974

Local name of dam or water body: _____

Owner: LAURENCE DESROSTERS ~~Destrosters~~ Address: 3029 BROWN AVE. MANCHESTER.

Owner was/was not interviewed during inspection.

Drainage Area: _____ sq. mi. Stream: Cohas Brook

Pond Area: _____ Acre, Storage _____ Ac-Ft. Max. Head ~15 Ft.

Foundation: Type _____, Seepage present at toe - Yes/No, _____

Spillway: Type Cut Stone, Freeboard over perm. crest: _____,

Width ± 80, Flashboard height _____,

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type split Stone, Condition: Good, Fair, ~~Poor~~

Gates or Pond Drain: Size Ruins Capacity _____ Type _____

Lifting apparatus _____ Operational condition _____

Changes since construction or last inspection: none since D.M.R.'s report of 5-2-72. or V.A.K's report of 6-2-64. Dam has silted in. Approx. 1" of water flowing over spillway

Downstream development: RT. 3A & Ruins of Dam # 150.05

This dam ~~would~~/would not be a menace if it failed.

Suggested reinspection date: _____

Remarks: A lot of debris has been building up in the stream (logs, trees, & junk) and may cause a tailwater backup problem in the future. Stream discharges into the Merrimack River approx. 2000' downstream of dam # 150.05. Recommend stream be cleaned, abutments replaced, and the construction of a step log section at the gate section ruins.

May 2, 1972

Mr. Barney Reen
Public Works Director
Manchester, New Hampshire

Dear Mr. Reen:

On April 25, 1972, I inspected the dam on Cohas Brook located easterly of Route 3A in South Manchester. The inspection was the result of a call from your engineering office in regard to the condition of the dam.

At the time of the inspection approximately eight to twelve inches of water was going over the entire length of the spillway and the deteriorated wall that formed the original sluiceway. The sluiceway was partially filled with rotted timbers from the original sluiceway walls, broken gate or water wheel mechanisms and other debris.

Unless the flow through the present sluiceway is stopped, the water will eventually erode the remaining sluiceway wall and reduce the pond to a natural brook. At this time, it is my opinion that there is no immediate danger of the dam suddenly breeching. With the present flow the eroding of the sluiceway wall will be gradual, but this condition should be corrected in the near future. An inexpensive possible remedy would be a reinforced concrete core wall between the present spillway and the left abutment with stabilizing material on each side of the core wall.

It is my understanding that a Mr. Desrocher owns the dam and from reading a 1964 inspection report on this structure, Mr. Desrocher did not intend to maintain this dam. The Water Resources Board could bring this matter to his attention and request that he repair the structure at his expense, but it is very doubtful that he would be receptive to such a suggestion. The Board could force the issue and have a public hearing on this matter and order him to repair the structure if it were a public menace, but Mr. Desrocher could also request permission from the Board to abandon the dam, whereby the Board would possibly require him to breech the structure because of safety requirements. This would present a problem for the city if it wants to preserve the pond and the property owners surrounding the water body.

The Water Resources Board can acquire dams only by legislative processes, and this can take a period of several years depending on local interest. I will be glad to meet with you if you need any additional information.

Very truly yours,

Donald M. Rapoza
Water Resources Engineer

DMR/jb

150.2

file

DATE: April 28, 1972

FROM: Donald M. Rapoza
Water Resources Engineer

SUBJECT: Dam Inspection on Cohas Brook in Manchester
(Pine Island Amusement Park)

TO: Vernon A. Knowlton
Chief Water Resources Engineer

On April 25, 1972, I inspected the dam on Cohas Brook in Manchester (Pine Island Amusement Park). The city engineer's office in Manchester called this office regarding the leaking dam on Cohas Brook and requested an investigation.

At the time of the inspection, water approximately 8 to 12 inches was going over the deteriorated wall which originally formed a sluiceway next to the left abutment.

Old rotted timbers, large boulders, parts of gate mechanisms, and other debris had fallen or been placed into the sluiceway.

The dam is in no immediate danger of breeching, but the existing condition should be corrected. Otherwise, the gradual eroding of the sluiceway wall will eventually eliminate the existing pondage. The problem could be checked with a concrete core wall with stabilizing fill material on either side of the wall or an impervious, compacted fill in the sluiceway.

I spoke with a local resident, Mr. James Wooded who resides on Route 3A, and he stated that a Mr. Desrocher owned the dam and from reading your memo on June 3, 1964 inspection, a Mr. Desrocher claims ownership to the dam and did not intend to maintain the dam at that time and I assume his position has not changed. Therefore, as suggested in your memo it would be in the best interest of all concerned that the City of Manchester acquire ownership of this property.

DMR/jb

Form WCC. 1
7/30/37

THE STATE OF NEW HAMPSHIRE

County of Hillsboro, ss. 1-7-52 19__

PETITION FOR APPROVAL OF THE ~~CONSTRUCTION OR~~
REPAIR OF DAM AT Manchester NH

TO THE WATER ~~CONTROL COMMISSION~~ Department of Public Works:

In compliance with the provisions of Laws of 1937, c. 133, an Act establishing a Water Control Commission,

~~We~~, I, Harry E Prince
(Here state name of person or persons, partnership, association, corporation, etc.)

hereby petition the Water ~~Control Commission~~ for approval ~~to construct, to reconstruct~~, to make repairs to, a dam ~~across~~ (cross out portion not applicable)
across Cohas Brook
(Here state name of stream or body of water)

at a point ~~about~~ 181 ft above Brown Ave Route 3A
(Here give location, by distance from mouth of stream, county or municipal boundary)
Manchester NH

in the town (s) of "

in accordance with PRELIMINARY PLANS, and SPECIFICATIONS FILED WITH THIS APPLICATION and made a part hereof.

Form WCC. 1-p. 2
7/30/37

The purpose of the proposed construction is power
(Here briefly state use to
maintain a higher water level on
which stored water is to be put)
Pine Island Pond for Recreation
Purposes

The construction will consist of Closing off R.R. Water Wheel
(Here give brief description of work con-
Repairing Wheel intake section
templated including height of dam)
& replacing Flash Boards

All land to be flowed is not owned by applicant.

New Pine Island Park Co
by Geo A. Foreman
Pres & Treas
Address c/o 233 Prospect St
Manchester N.H.
Roland S Nickless

Note: This application together with plans, specifications and information and data filed in connection herewith will remain on file in the office of the Water Control Commission.

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

10 A

TOWN MANCHESTER DAM NO. 150.5 STREAM COHAS BROOK

OWNER ~~City of Manchester~~ ADDRESS MANCHESTER

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 3 JUNE 19 42 accompanied by ———

NOTES ON PHYSICAL CONDITION

Abutments FAIR-

Spillway FLASHBOARD SUPPORTS PERMANENT-MANCHESTER WATER WORKS HAD TO REMOVE F.B. IN 1936 TO SAVE CUT THRU AT LOW PLACE N END.

Gates TIMBER AT FLUME POOR-

Other

CHANGES SINCE LAST INSPECTION

FUTURE INSPECTIONS

This dam (is) (~~is not~~) a menace because PLANKS IN FLUME IN POOR CONDITION. DAM IS AT QUITE A HIGHER EL. THAN ROAD AND HOUSES BELOW. SPILLWAY CAPACITY INADEQUATE.

REMARKS GREATEST DANGER TO NORTH END IF FLASHBOARDS IN DURING FLOOD WATERS

Copy to ~~Owner~~	Date

C. D. COLMAN
INSPECTOR

B-14

(Additional Notes Over)

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 150.05

Town Manchester : County Hillsboro

Stream Cohas Brook

Basin-Primary Merrimack R. : Secondary Cohas Brook

Local Name "Pine Island Park"

Coordinates—Lat. 42° 55' + 5400 : Long. 71° 25' + 9000

GENERAL DATA

Drainage area: Controlled 65 Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total ..... Sq. Mi.

Overall length of dam 80' ft.: Date of Construction .....

Height: Stream bed to highest elev. 17 ft.: Max. Structure 12' 6" ft.

Cost—Dam .....: Reservoir .....

DESCRIPTION - Gravity— Split Stone on Earth

Waste Gates

Type .....

Number .....: Size ..... ft. high x ..... ft. wide

Elevation Invert .....: Total Area ..... sq. ft.

Hoist .....

Waste Gates Conduit

Number .....: Materials .....

Size ..... ft.: Length ..... ft.: Area ..... sq. ft.

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width .....: Elev. ..... ft.

Slopes—Upstream ..... on .....: Downstream ..... on .....

Length—Right of Spillway .....: Left of Spillway .....

Spillway

Materials of Construction .....

Length—Total 68' 6" ft.: Net ..... ft.

Height of permanent section—Max. ..... ft.: Min. ..... ft.

Flashboards—Type IRON A FRAME — : Height ..... ft.

Elevation—Permanent Crest 148.57 : Top of Flashboard .....

Flood Capacity 2100 cfs.: 32 cfs/sq. mi.

Abutments

Materials: SPLIT STONE

Freeboard: Max. 4' 6" ft.: Min. ..... ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER ~~City of Manchester~~

REMARKS Conservation--- Recreation

Tabulation By A A N Date January 30, 1939

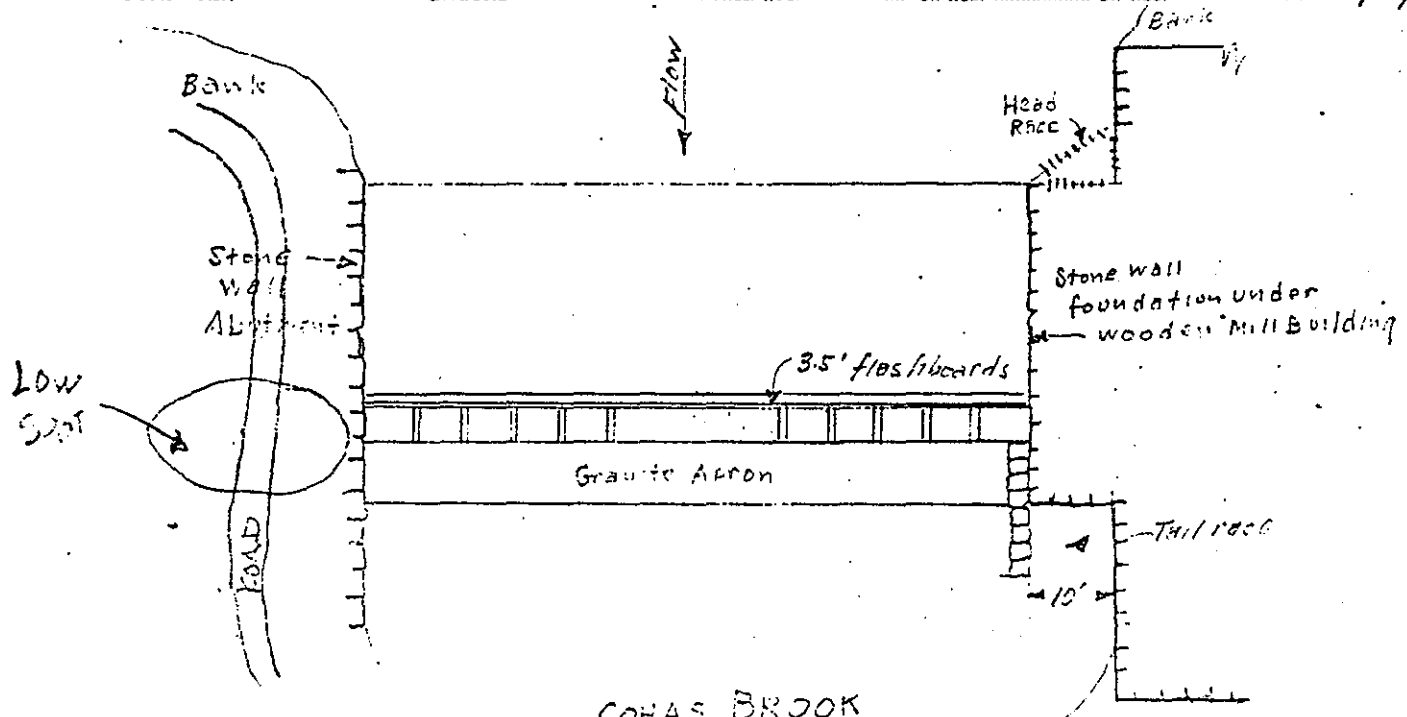
&B21284

HAMPSHIRE RESOURCES BOARD CONCORD, N. H.

PROJECT Survey of Existing N.H. Dams FILE 73

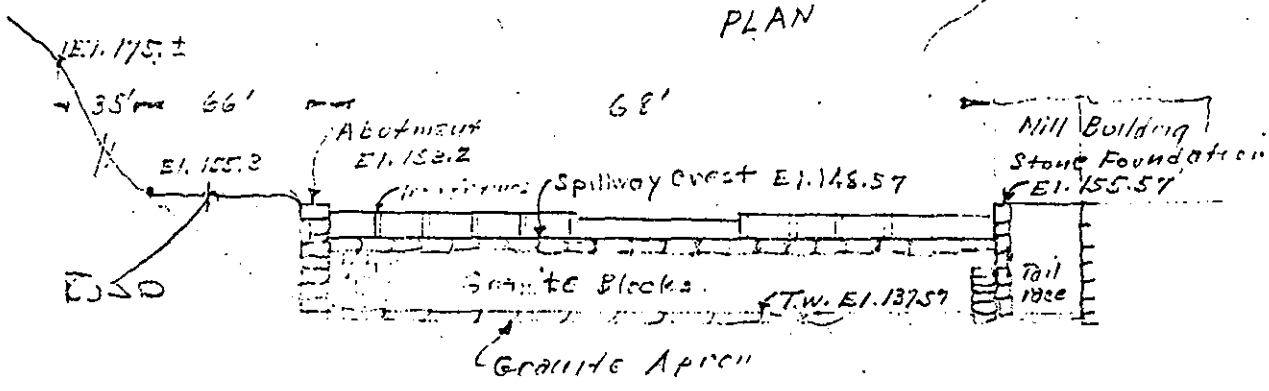
SUBJECT Waterman Worsted Co. Inc. and Devonshire Mills Dam on Cohas Brook in Manchester. (Upper) ACC.

COMPUTER H.L. Rossire CHECKER CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC. DATE 8/13/37



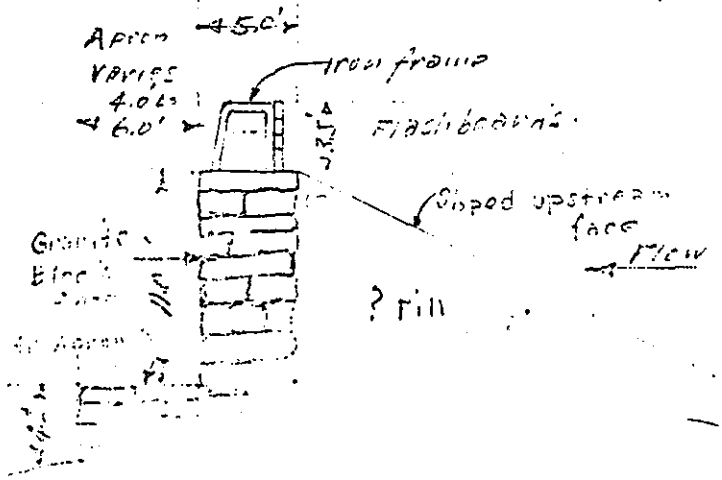
COHAS BROOK

PLAN



ELEVATION

Scale 20' = 1 inch.



SECTION Thru Spillway

Copied from sketch by Assistants of U.S.G.S. dated Sept. 9, 1936

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Merrimack NO. 5 — — I-5468 (68AE
RIVER Cohas Brook MILES FROM MOUTH 67.90 D.A.SQ.MI. 6.5
TOWN Manchester OWNER City of Manchester (on Tax Sale)
LOCAL NAME OF DAM Goffs Falls Devonshire Mills Dam #2 Also Waterman Wo
BUILT 1896 DESCRIPTION Gravity — Split Stone on Earth Co Inc #2
See No

POND AREA-ACRES DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 17 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 60± MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. 148.57 LOCAL GAGE
TAILWATER ELEV.U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 68.5 FREEBOARD-FT. 4.5
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST None (3.5' AE)
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

REMARKS Condition Stone Good Timber Poor No damage 1936 flood except loss of flashboard
6 ✓ into Merrimack River.

Note: A.E. has 2 sheets for this dam. Photos on each show same dam.
Probably Devonshire Mills on one bank and Waterman Worsted Co Inc. on other (51
co-ordinates from AE
42° 55' + 5200 ft
71° 25' + 9200 ft.

POWER DEVELOPMENT

UNITS	NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE Conservation — Recreation formerly power for Waterman Mill

REMARKS Manager A.E. got information from Mrs Rhea LaSalle (also Chas Shutt caretaker) abutter. City of Manchester foreclosed tax liens. Water rights owned by Harry Stephenson, 146 Summer St. Boston, Mass.

Photo D-69

DATE 9/4/36 AE 5/24/36

State of New Hampshire
PUBLIC SERVICE COMMISSION

C O P Y

October 14, 1936

M. J. Healy, Chairman
Board of Assessors
Manchester, New Hampshire

Dear Sir:

In reply to your letter of October 15 in which you informed us that the dam in Cohas Brook, which was formerly owned by the Devonshire Mills, is now the property of the City of Manchester. We are enclosing a copy of our dam inspection report and the bill for said inspection.

Also we are enclosing a letter written to the Devonshire Mills in regard to the condition of the dam. Will you kindly pass this correspondence on to the proper person in your City Government. Thanking you very kindly for the information you furnished in regard to the ownership of the dam, I am

Very truly yours,

N. H. PUBLIC SERVICE COMMISSION

D. Waldo White
Chief Engineer

DWW/a

enc.

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5488

TOWN	MANCHESTER	TOWN NO. 5	STATE NO. 150.15
RIVER STREAM	Cohas Brook		
DRAINAGE AREA	65 Sq. Mi.	POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Split Stone		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	17'	TOP OF DAM TO SPILLWAY CRESTS	4'-6"
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	68'-6"	LENGTH OF DAM	Approx. 80'
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	None		
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS			

REMARKS

OWNER: ~~Derryfield Mills~~ City of Manchester.

CONDITION: Stone work good - Timber flume poor.

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 24, 1936, according to notification to owner dated Aug. 14, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 31, 1936
Copy to Owner

State of New Hampshire
PUBLIC SERVICE COMMISSION

C O P Y

August 14, 1936

City Engineer
Manchester, N. H.

Dear Sir:

Pursuant to the duty imposed upon it by Chapter 218 of the Public Laws of New Hampshire, the Public Service Commission will inspect the dams in the vicinity of Manchester on August 24, 1936.

Town Records indicate that you are the owner of two dams in the Town of Manchester, New Hampshire, which will be inspected on the above mentioned date. We should be pleased to have you or your representative present during this inspection if you so desire.

Under the statute all dams in your vicinity will be inspected to determine whether or not they would be a menace to the public safety if improperly maintained. Dams which would not be a menace to the public safety will not be subject to a later periodic inspection. It is our intention to inspect dams which would be a menace to the public safety if improperly maintained about once every five years.

There will be a nominal charge for such dams as would be a menace to the public safety if not constructed and maintained properly. We hope you will be present when our inspector views your dam so that you may avail yourself of his services.

Very truly yours,

N. H. PUBLIC SERVICE COMMISSION

D Waldo White

D. Waldo White
Chief Engineer

Co.

No. 150.05

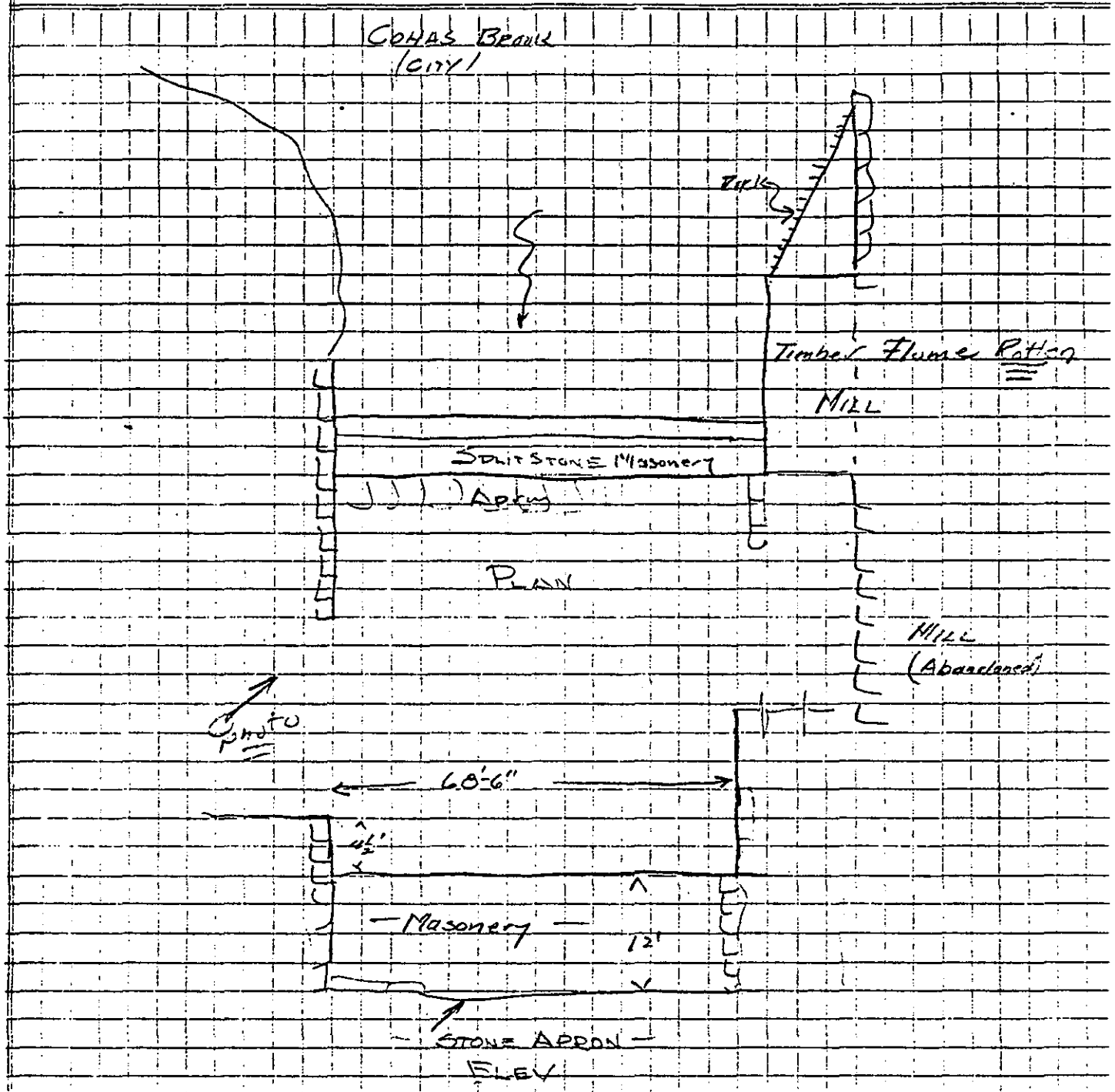
CALCULATION SHEET

Date Aug 24, 1936

Refers to

Made By ACB

3646



7919

TOWN NO. 6 TOWN Manchester, N. H. NO. 123 PAGE NO. 7

NAME OF COMPANY City of Manchester

HOME ADDRESS Manchester, N. H.

DRAINAGE AREA 43 SQ. MI. HEAD 44 FT.

RIVER Conas Brook RATE SEC. FT. PER SQ. MI. 90% TIME 1.0

RESOURCES

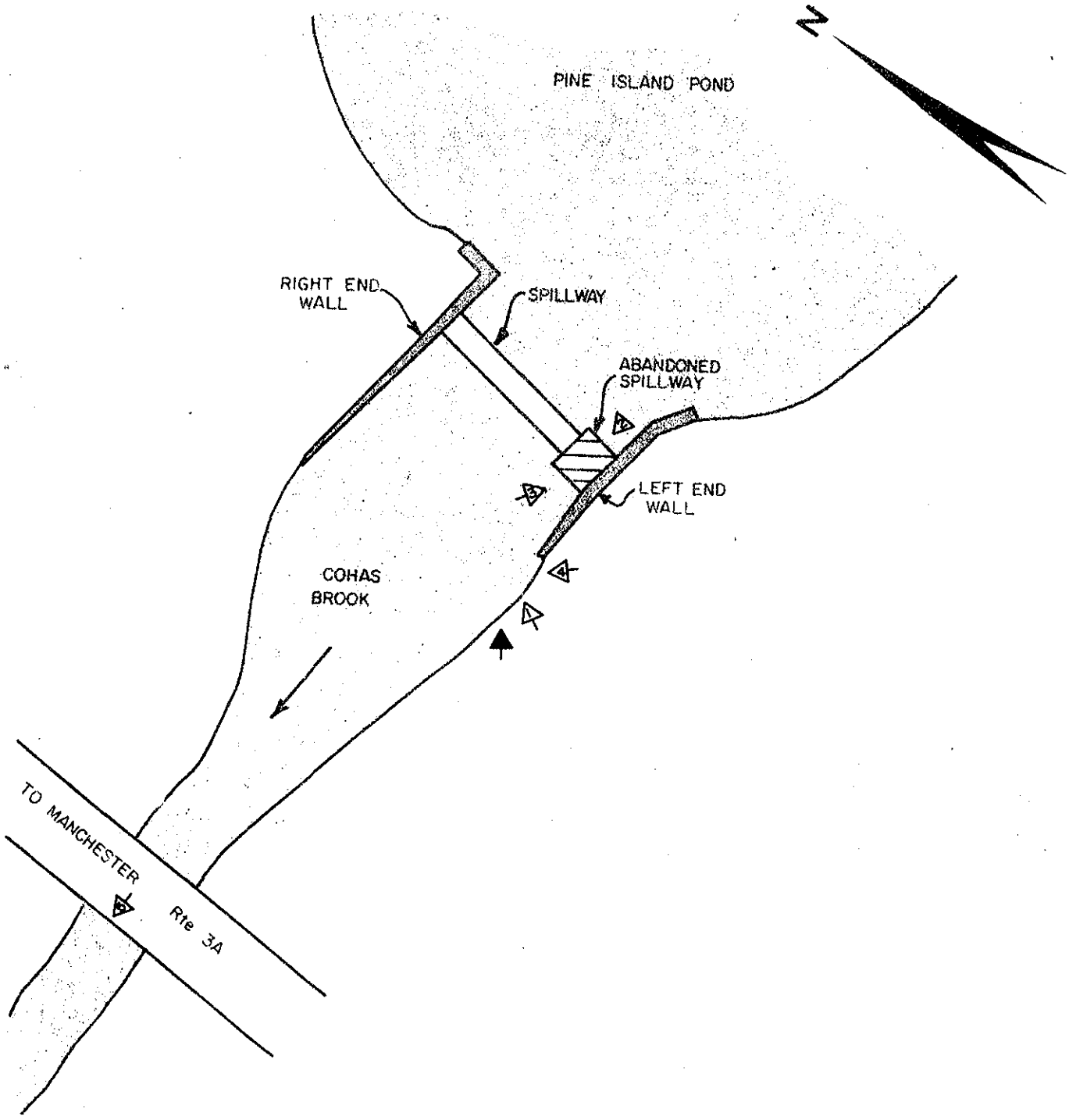
FOR CENTRAL STATIONS		FOR ISOLATED INDUSTRIAL PLANTS	
WHEEL CAP. H. P.	PRIMARY H. P. 90% TIME	WHEEL CAP. H. P.	PRIMARY H. P. 90% TIME
		500	171.98

USES

FOR CENTRAL STATIONS		FOR ISOLATED INDUSTRIAL PLANTS		
K. V. A. CAPACITY	ANNUAL KW. H. OUTPUT	K. V. A. CAPACITY	ANNUAL KW. H. PROD. AND CONS. ELECT.	ANNUAL KW. H. PROD. AND CONS. MECH.

APPENDIX C

PHOTOGRAPHS



OVERVIEW PHOTO

APPENDIX C PHOTO

GOLDBERG · ZOINO & ASSOCIATES, INC.
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PHOTO LOCATION PLAN

FILE No. 2605

GOFFS FALLS DAM MANCHESTER, NEW HAMPSHIRE

SCALE SCHEMATIC

DATE OCT 1980

1. Right Abutment and End Wall - Note Undermined Section Downstream of Spillway

2. Sluiceway at Left Abutment - Note Rubble and Debris Blocking Channel

3. Upstream View of Sluiceway - Note Missing Portion of Left Endwall

4. Channel Immediately Downstream of Dam

5. Channel Downstream of Highway Bridge

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Dam Rating Curve

A schematic sketch of the overflow section of this dam is shown on the next page. This sketch is based on the N.H.W.R.B. inventory (1937) and recent field inspection.

Main spillway discharge

$$Q_1 = CLH^{1.5}$$

C = 3.1 (Broad crested weir)

L = 68.5

H = head on spillway crest (datum elev. 148.6)

$$Q_1 = 3.1 \times 68.5 \times H^{1.5}$$

Flow over the filled portion of the old raceway

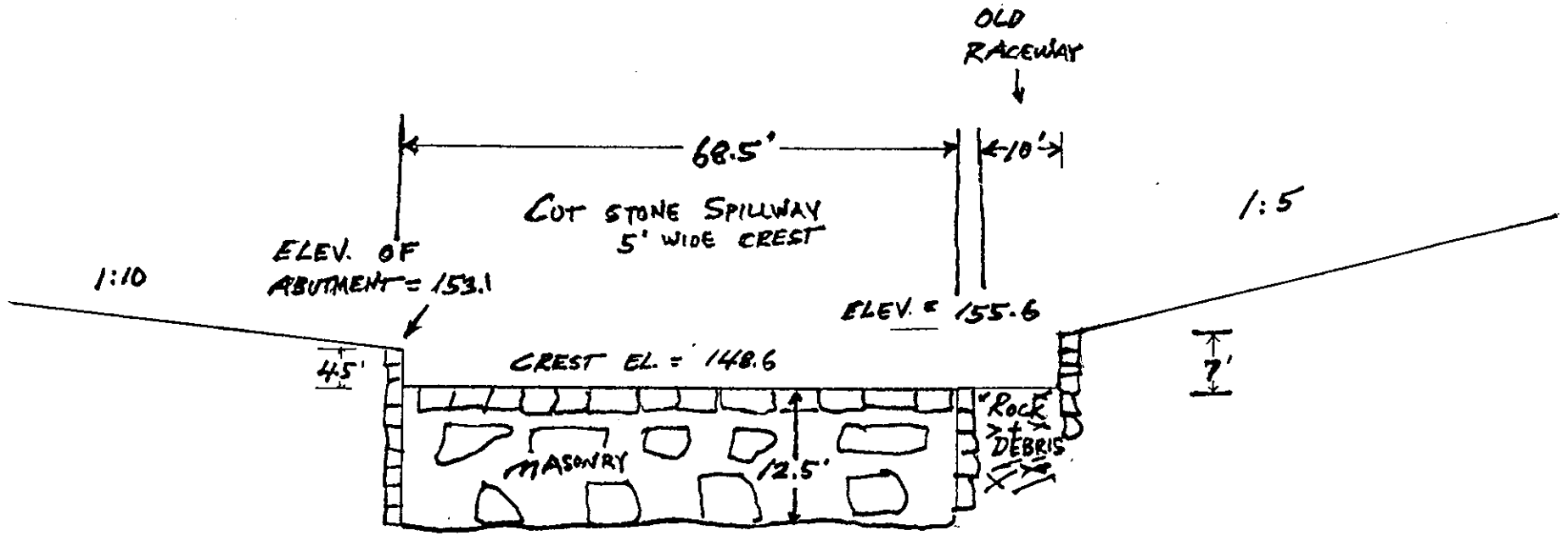
C = 2.6

L = 10'

head = H

$$Q_2 = 2.6 \times 10 \times H^{1.5}$$

SCHEMATIC OF GOFFS FALLS DAM (NOT TO SCALE)



VIEW LOOKING UPSTREAM

SKETCH IS FROM "SURVEY OF EXISTING N.H. DAMS" AND FIELD NOTES

Left Abutment Overflow

C = 2.6

L = 5 x (H-7.0)

head = 0.5 x (H-7.0)

$$Q_3 = 2.6 \times 5 \times (H-7.0) \times (0.5(H-7.0))^{1.5}$$

Right Abutment Overflow

C = 2.6

L = 10 x (H-4.5)

head = 0.5 x (H-4.5)

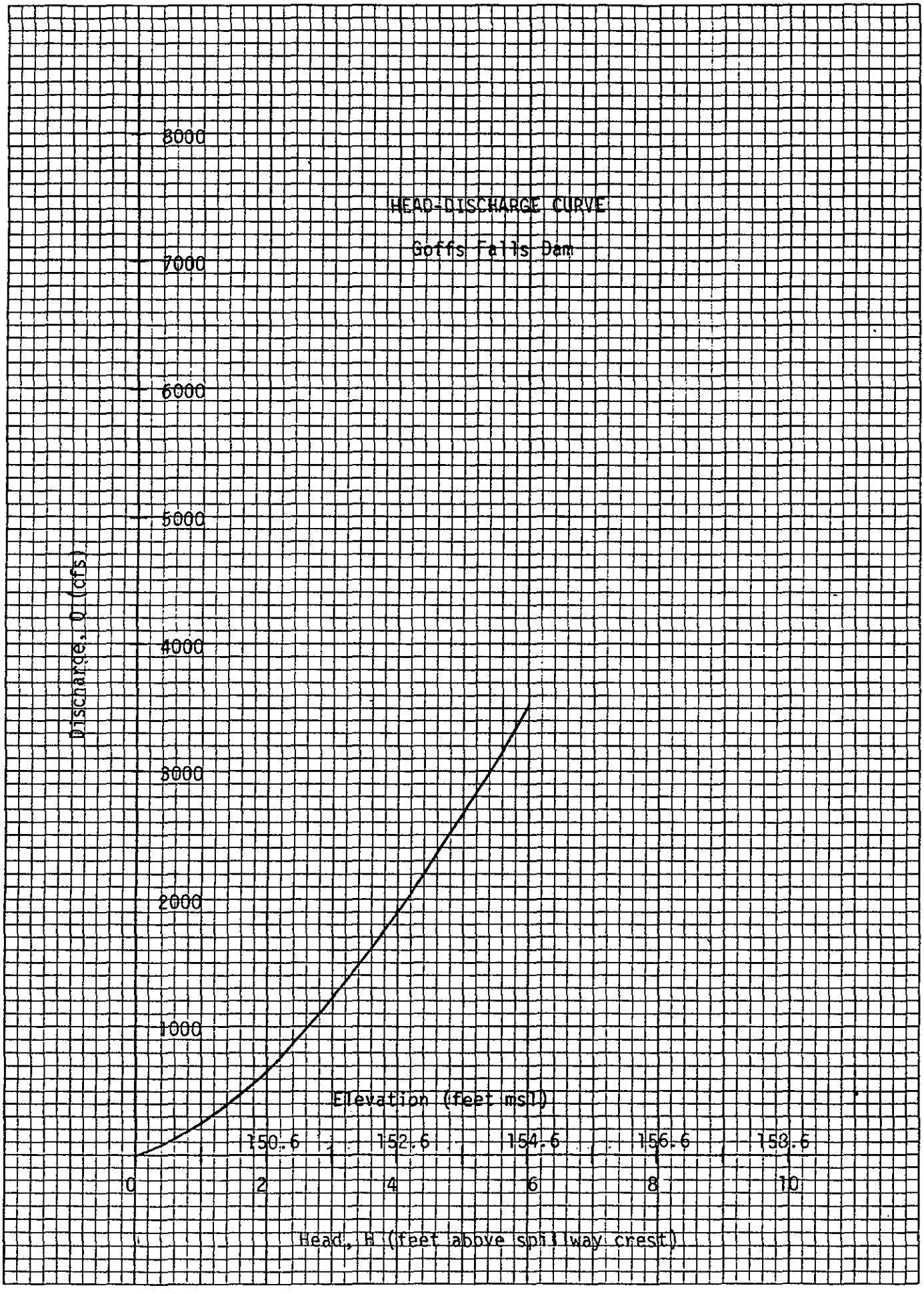
$$Q_4 = 2.6 \times 10 \times (H-4.5) \times (0.5 \times (H-4.5))^{1.5}$$

A BASIC program was written to calculate the head-discharge function at the dam. A listing of the program is shown on the next page, followed by tabulated output and a plotted curve.

```
100 REM - HEAD-DISCHARGE CURVE FOR GOFF FALLS DAM
110 REM - STORED ON TAPE B1 FILE 37
120 PAGE
130 PRINT USING 140:
140 IMAGE 20T"HEAD VS. DISCHARGE FOR GOFF FALLS DAM"
150 PRINT USING 160:
160 IMAGE //12T,"HEAD" 32T"DISCHARGE"
170 PRINT USING 180:
180 IMAGE 11T"(FEET)" 34T"(CFS)"
190 PRINT USING 200:
200 IMAGE 23T"TOTAL      SPILLWAY   ABUTMENTS"
210 PRINT " "
220 FOR H=0 TO 10 STEP 0.5
230 O1=3.1*68.5*H↑1.5
240 O2=2.6*10*H↑1.5
250 O3=0
260 O4=0
270 IF H<4.5 THEN 310
280 O4=2.6*10*(H-4.5)*(0.5*(H-4.5))↑1.5
290 IF H<7 THEN 310
300 O3=2.6*5*(H-7)*(0.5*(H-7))↑1.5
310 T1=O1+O2
320 T2=O3+O4
330 T3=T1+T2
340 PRINT USING 350:H,T3,T1,T2
350 IMAGE 12T,2D.1D,12D,12D,10D
360 NEXT H
370 END
```

HEAD VS. DISCHARGE FOR GOFF FALLS DAM

HEAD (FEET)	DISCHARGE (CFS) TOTAL	SPILLWAY	ABUTMENTS
0.0	0	0	0
0.5	84	84	0
1.0	238	238	0
1.5	438	438	0
2.0	674	674	0
2.5	942	942	0
3.0	1239	1239	0
3.5	1561	1561	0
4.0	1907	1907	0
4.5	2275	2275	0
5.0	2666	2665	2
5.5	3084	3074	9
6.0	3528	3503	25
6.5	4002	3950	52
7.0	4505	4414	91
7.5	5040	4896	144
8.0	5609	5393	215
8.5	6214	5907	307
9.0	6856	6435	421
9.5	7538	6979	559
10.0	8261	7537	724


HEAD-DISCHARGE CURVE
Goffs Falls Dam
8000
7000
6000
5000
4000
3000
2000
1000
Discharge, Q (cfs)
Elevation (feet msl)
150.6
152.6
154.6
156.6
158.6
0
2
4
6
8
10
Head, H (feet above spillway crest)

Stage Storage Curve

Normal pool (water surface at spillway crest)

Volume = 150 acre-ft.

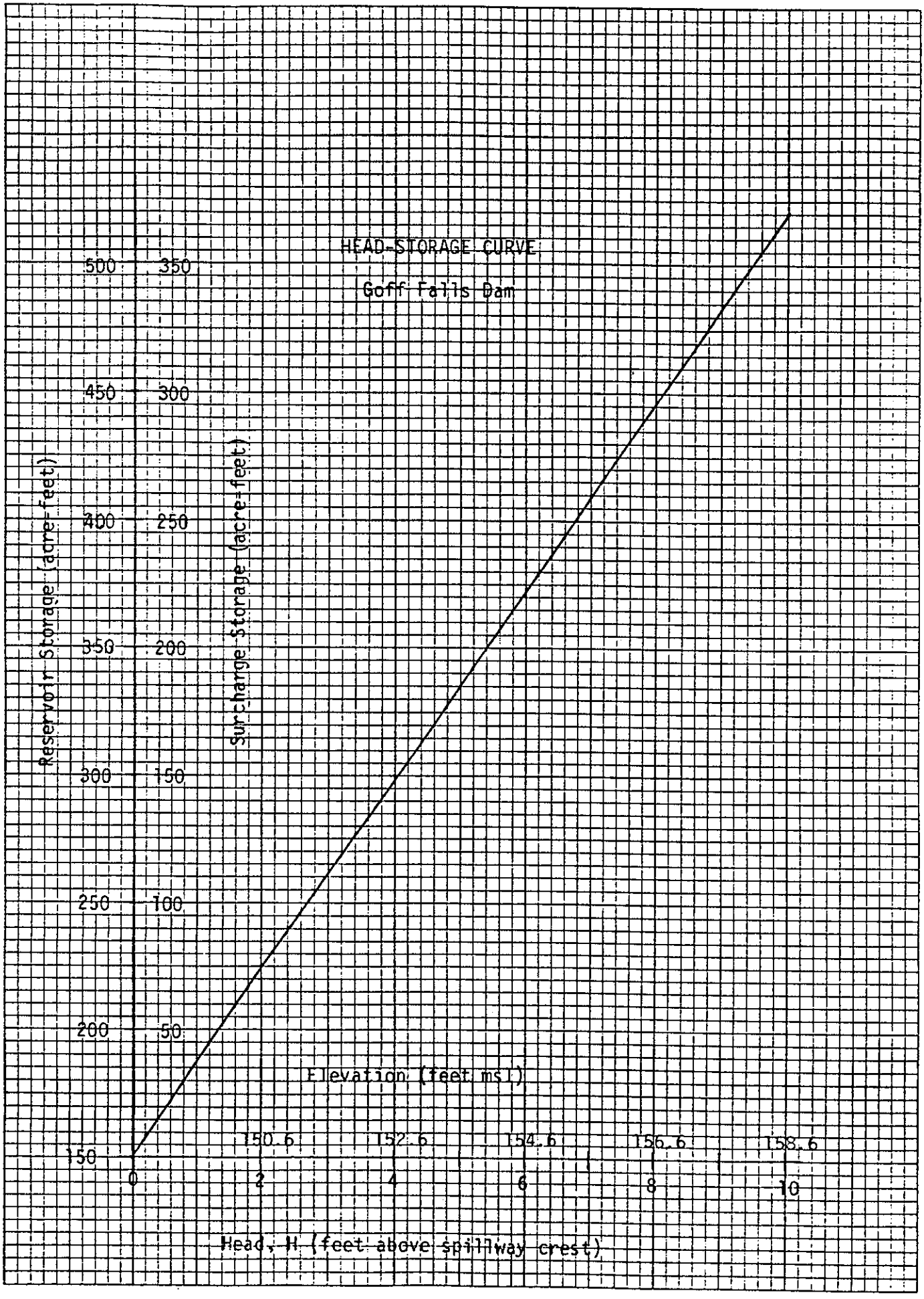
Surface Area = 37 acres

Assuming no spreading of the pool, storage volumes at higher elevations are estimated by

Volume = 150 + 37 x H

H = head on spillway crest (elev. 148.6)

A stage-storage plot is shown on the following page.


HEAD-STORAGE CURVE
Goff Falls Dam
Reservoir Storage (acre-feet)
Surcharge Storage (acre-feet)
500
450
400
350
300
250
200
150
350
300
250
200
150
100
50
0
Elevation (feet msl)
150.6
152.6
154.6
156.6
158.6
2
4
6
8
10
Head, H (feet above spillway crest)

DAM FAILURE ANALYSIS

See Schematic

Outflow at failure = outflow through breach + normal outflow at failure elevation of pool.

Normal Outflow at Failure

Assume the dam fails at the top of the left abutment.

Height above crest = 4.5'

Height above streambed = 17.0'

Consider Two Spillway Sections:

1. Main Spillway

   L = 68.5' WIDTH = 5' C = 3.1 (Broad Crested Weir)

   $Q = CLH^{1.5} = 3.1\ (68.5)\ (4.5)^{1.5} = \underline{2030}$ cfs

2. Old Raceway Filled With Debris → Low "C" value

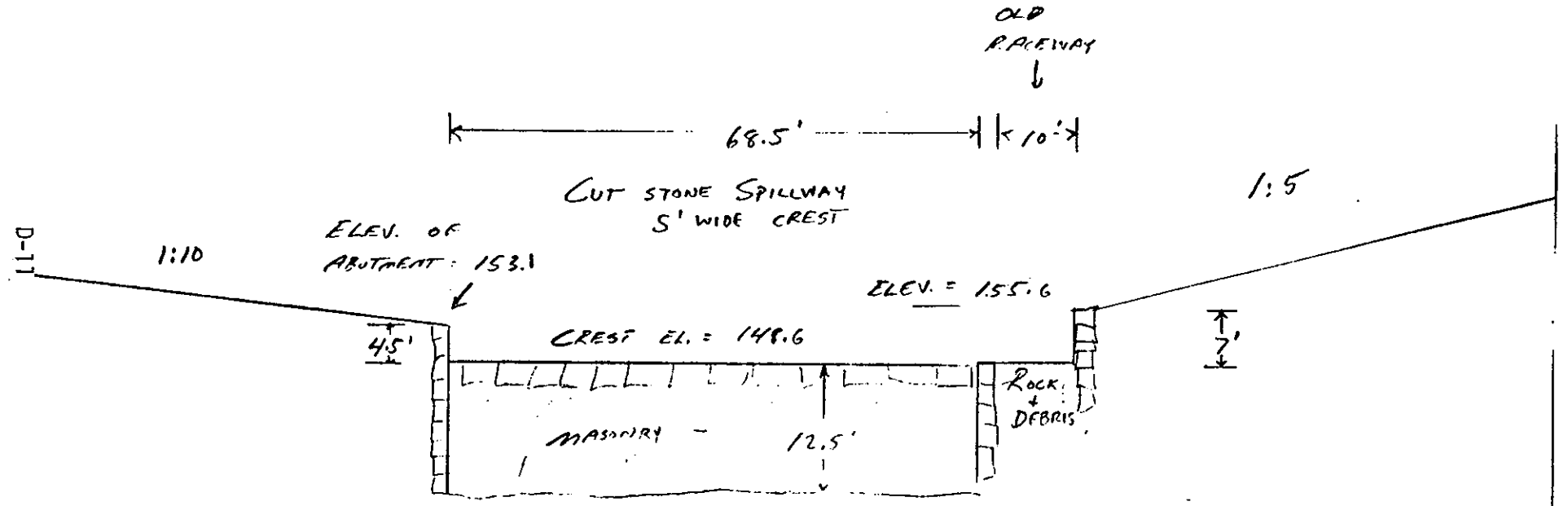
   L = 10' C = 2.6

   $Q = CLH^{1.5} = 2.6\ (10)\ (4.5)^{1.5} = \underline{250}$ cfs

Normal Outflow at Failure = 2030 + 250 = 2280 cfs

SCHEMATIC OF GOFFS FALLS DAM

(NOT TO SCALE)
(Looking Upstream)



SKETCH IS FROM "SURVEY OF EXISTING N.H. DAMS" AND FIELD NOTES (1937)

Breach Outflow

$Q_{pl} = 8/27\ W_b\ (\sqrt{g})\ (Y_0^{1.5})$

W_b = Width of Breach

$\leq$ .4 (Width of dam at ½ height)

Use $W_b = .4\ (78.5) = 31.4'$

Y_0 = Pool elevation at failure - channel invert

$Y_0 = 17.0'$

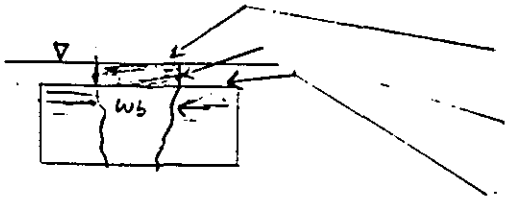
$Q_{pl} = (8/27)\ (31.4)\ \sqrt{32.2}\ (17)^{1.5}$

= 3700 cfs

Normal outflow + Breach outflow

= 2280 + 3700 = 5980 cfs

But, there will be no normal weir flow where the dam is breached:



Water surface at failure

No normal flow at failure

Spillway crest

Subtract weir flow for the 31.4 width of breach

$3.1 * (31.4)\ (4.5)^{1.5}$ = 930 cfs

Total corrected outflow at failure

= 5980 - 930 = 5050 cfs

Downstream Flooding

About 300' downstream of Goffs Falls dam, Cohas Brook flows under Route 3A through a 35' x 12' bridge opening.

Bridge Headwater

Using "Hydraulic Charts for the Selection of Highway Culverts", HEC Circular #5.

At failure flow of 5050 cfs:

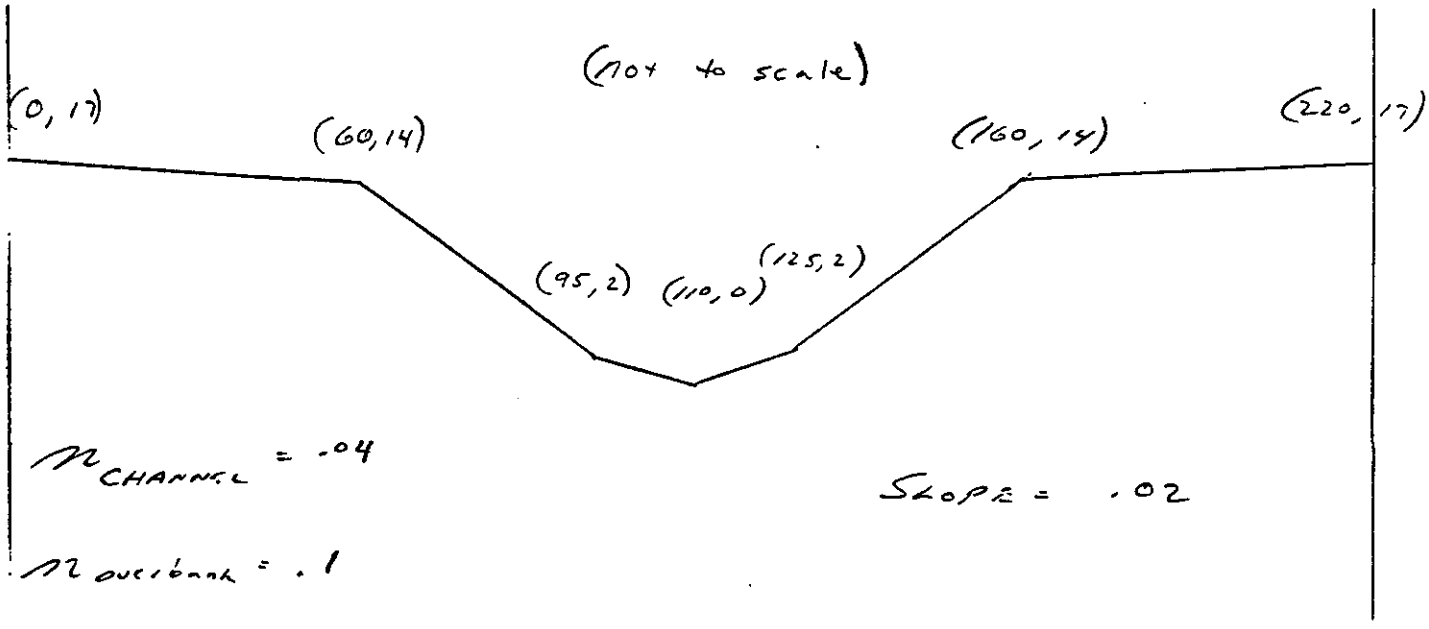
Q/B = 5050/35 = 144

HW/D = 1.22 HW = 12 * 1.22 = 14.6'

At the peak failure flow of 5050 cfs, the water surface rises 2.6 feet above the low chord, which is a stell I-beam. It is not expected that the bridge will survive such extreme conditions.

In the reach from the dam to the Route 3A bridge are two houses, one is high above the streambed, but one on the right bank is about 14'-16' above the streambed, and it may experience minor flooding due to the bridge backwater depth of about 14-15 feet.

Below is shown a typical cross section downstream of the bridge, and on the next page is the cross section uniform flow rating table, computed with a BASIC program.



===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.5	1.9	7.6	0.2	0.7	3.1
1.00	1.0	7.5	15.1	0.5	4.7	19.8
1.50	1.5	16.9	22.7	0.7	13.8	58.4
2.00	2.0	30.0	30.3	1.0	29.8	125.7
2.50	2.5	45.7	33.3	1.4	56.4	247.6
3.00	3.0	62.9	36.4	1.7	90.6	402.8
3.50	3.5	81.6	39.5	2.1	132.2	589.8
4.00	4.0	101.7	42.6	2.4	181.6	808.1
4.50	4.5	123.2	45.7	2.7	238.8	1057.1
5.00	5.0	146.3	48.8	3.0	304.1	1336.8
5.50	5.5	170.7	51.8	3.3	377.9	1647.1
6.00	6.0	196.7	54.9	3.6	460.3	1988.1
6.50	6.5	224.1	58.0	3.9	551.6	2360.0
7.00	7.0	252.9	61.1	4.1	652.0	2763.0
7.50	7.5	283.2	64.2	4.4	762.0	3197.3
8.00	8.0	315.0	67.3	4.7	881.7	3663.3
8.50	8.5	348.2	70.3	5.0	1011.4	4161.2
9.00	9.0	382.9	73.4	5.2	1151.5	4691.4
9.50	9.5	419.1	76.5	5.5	1302.1	5254.2
10.00	10.0	456.7	79.6	5.7	1463.5	5850.0
10.50	10.5	495.7	82.7	6.0	1636.1	6479.2
11.00	11.0	536.3	85.8	6.3	1820.0	7142.1
11.50	11.5	578.2	88.8	6.5	2015.6	7839.2
12.00	12.0	621.7	91.9	6.8	2223.1	8570.8
12.50	12.5	666.6	95.0	7.0	2442.7	9337.3
13.00	13.0	712.9	98.1	7.3	2674.8	10139.3
13.50	13.5	760.7	101.2	7.5	2919.6	10976.9
14.00	14.0	810.0	104.3	7.8	3177.2	11850.8
14.50	14.5	865.0	124.3	7.0	3153.1	12414.8
15.00	15.0	930.0	144.3	6.4	3220.6	13139.4

From the rating table it can be seen that a peak failure flow of 5050 cfs corresponds to a water surface depth of about 9.3 feet, if uniform flow is assumed. About 400' to 500' downstream of the dam are two houses which are approximately 12' above the streambed and are therefore well above the failure flow elevation. Another 100' downstream are two more houses which are 14'-16' above the streambed and are also in no danger of flooding. On the left side of the brook, near the confluence with the Merrimack River, are the ruins of an abandoned factory which have no economic value.

Hazard Classification

In the 300' reach between Goffs Falls dam and the Route 3A bridge, failure of the dam would cause flood waters to rise about 2.6' above the steel I-beam low chord. It is expected that the bridge deck would not survive the flood wave. Only one house in the short reach between the dam and the bridge may have some minor cellar flooding due to the bridge backwater. Housing downstream of the bridge would not be affected by flooding. This dam has been classified as a significant hazard.

Test Flood Analysis

Size Classification - SMALL

Storage < 1000 acre-feet

Height < 40'

Hazard Classification - SIGNIFICANT

In the 300' reach between Goffs Falls dam and the Route 3A bridge, failure of the dam would cause flood waters to rise about 2.6' above the steel I-beam low chord. It is expected that the bridge deck would not survive the flood wave. Only one house in the short reach between the dam and the bridge may have some minor flooding due to the bridge backwater. Housing downstream of the bridge would not be affected by flooding.

Test Flood Selection

Per COE guidelines, a SMALL dam with SIGNIFICANT hazard potential should use a 100-year to ½ PMF Test Flood. Because only one structure would be seriously affected by dam failure, use the 100-year flood at the dam.

Determination of 100-year Flood leaving Massabesic Lake:

Massabesic Lake ∿ 4 miles U/S, is a large impoundment which controls ∿ 70% of the watershed runoff. A separate inflow determination and routing will be performed for Massabesic Lake using information provided in a separate inspection report for Massabesic Lake Dam (August, 1978).

Peak 100-year inflow:

Use the flood frequency regression equation published by the USGS in Progress Report on Hydrologic Investigations of Small Drainage Areas in New Hampshire by Denis R. Leblanc.

$$Q_{100} = 0.55\ A^{1.05}\ S^{0.56}\ I^{2.72}$$

A = 47 sq. mi. (drainage area)

S = 67 ft./mile (Basin slope)

I = 2.9 in/hour (max. 2 yr.-24 hr. precip.)

$Q_{100} = 0.55 \times 47^{1.05} \times 67^{0.56} \times 2.9^{2.72}$

= 5980 cfs

Total Runoff Volume

R.O. depth = ¼ x 19 = 4.75" (assumed for 100-year flood)

S = R.O. ÷ 12 x A x 640 (total runoff volume)

= 4.75 ÷ 12 x 47 x 640 = 11,900 AF

Storage Routing

$Q_{p2} = Q_{p1} (1-V/S)$

Q_{p1} = 5980 cfs

S = 11,900 AF

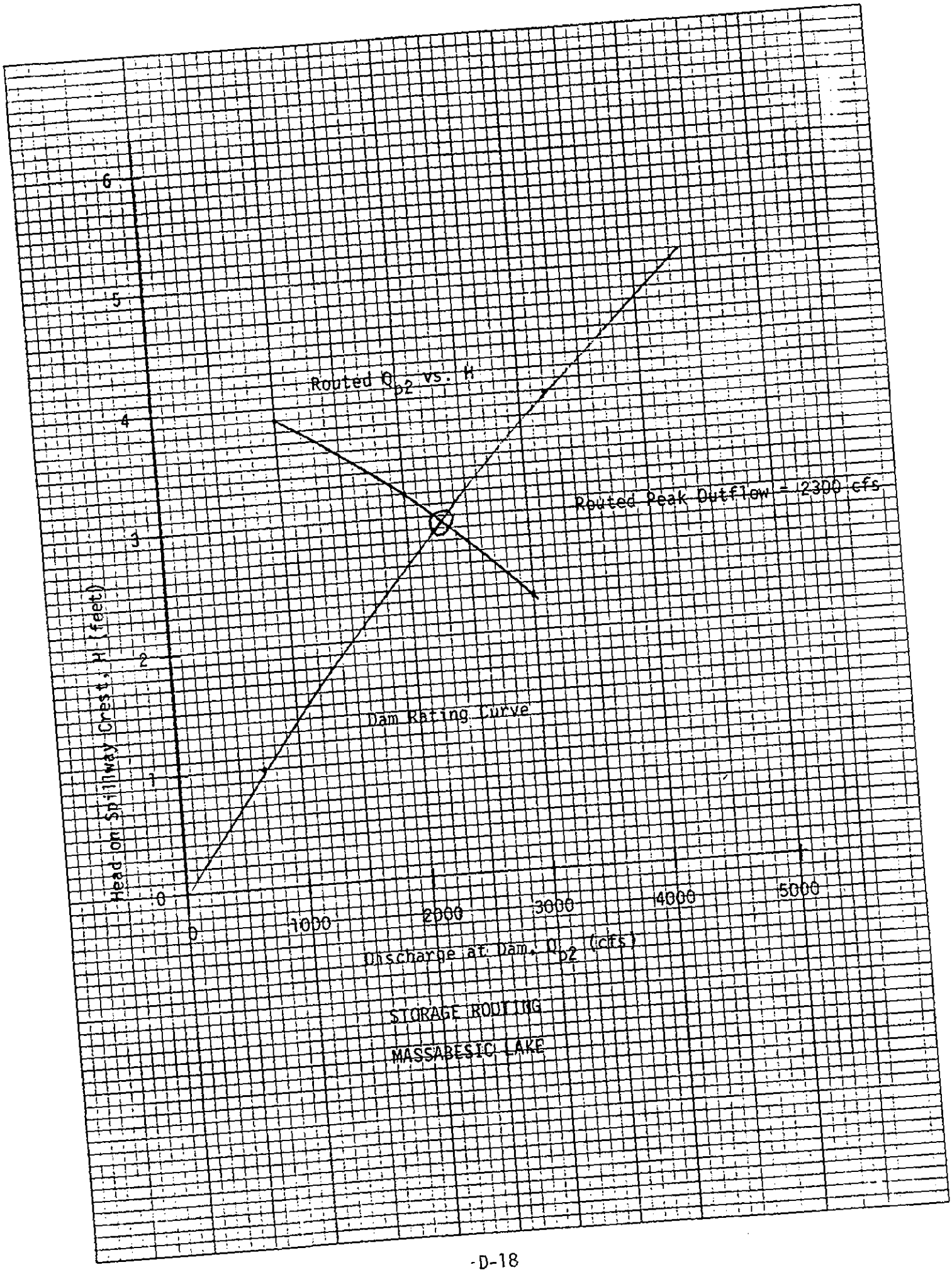
$V = 11{,}900 \left(1-\frac{Q_{p2}}{5980}\right)$

V is the reservoir surcharge storage volume associated with a routed peak outflow of Q_{p2}. H can be determined from V using the stage-storage curve for Massabesic Lake. (assume flashboards removed) These are tabulated below:

Q_{p2}	V	H
1000	9910	3.9
2000	7920	3.2
3000	5930	2.3

The above function is plotted along with the rating curve for Massabesic dam (assume flashboards removed) to find that peak outflow and pool level which satisfies both functions. See next page.

The routed peak outflow from Massabesic Lake = 2300 cfs.


Routed Q_{p2} vs. H
Routed Peak Outflow = 2300 cfs
Dam Rating Curve
Head on Spillway Crest, H (feet)
0
1
2
3
4
5
6
0
1000
2000
3000
4000
5000
Discharge at Dam, Q_{p2} (cfs)
STORAGE ROUTING
MASSABESIC LAKE

Peak 100-year inflow to Pine Island Pond from the uncontrolled watershed

A = 17 sq. mi.

S = 30 ft./mile

I = 2.9 in./hr.

$Q_{100} = 0.55 \times 17^{1.05} \times 30^{0.56} \times 2.9^{2.72}$

$= \underline{1300}$ cfs

Combined peak inflow to Pine Island Pond

$Q_{p1} = 2300 + 1300 = \underline{3600}$ cfs

(Note that this assumption of coinciding peaks will be an over-estimate to some degree)

Combined Total Runoff Volume

$S = R.O. \div 12 \times A \times 640$

R.O. = 4.75"

A = 65 sq. mi. (total watershed area)

$S = 4.75 \div 12 \times 65 \times 640$

$= \underline{16,470}$ AF

Storage Routine through Pine Island Pond

$$V = 16,470 \left(1-\frac{Q_{p2}}{3600}\right)$$

Q_{p2}	V	H
3400	915	24.7
3500	458	12.4
3600	0	0.0

It can be seen from the above table that there will be negligible attenuation of the Test Flood inflow due to temporary storage in Pine Island Pond.

$Q_{p2} = Q_{p1} = \underline{\underline{3600}}$ cfs

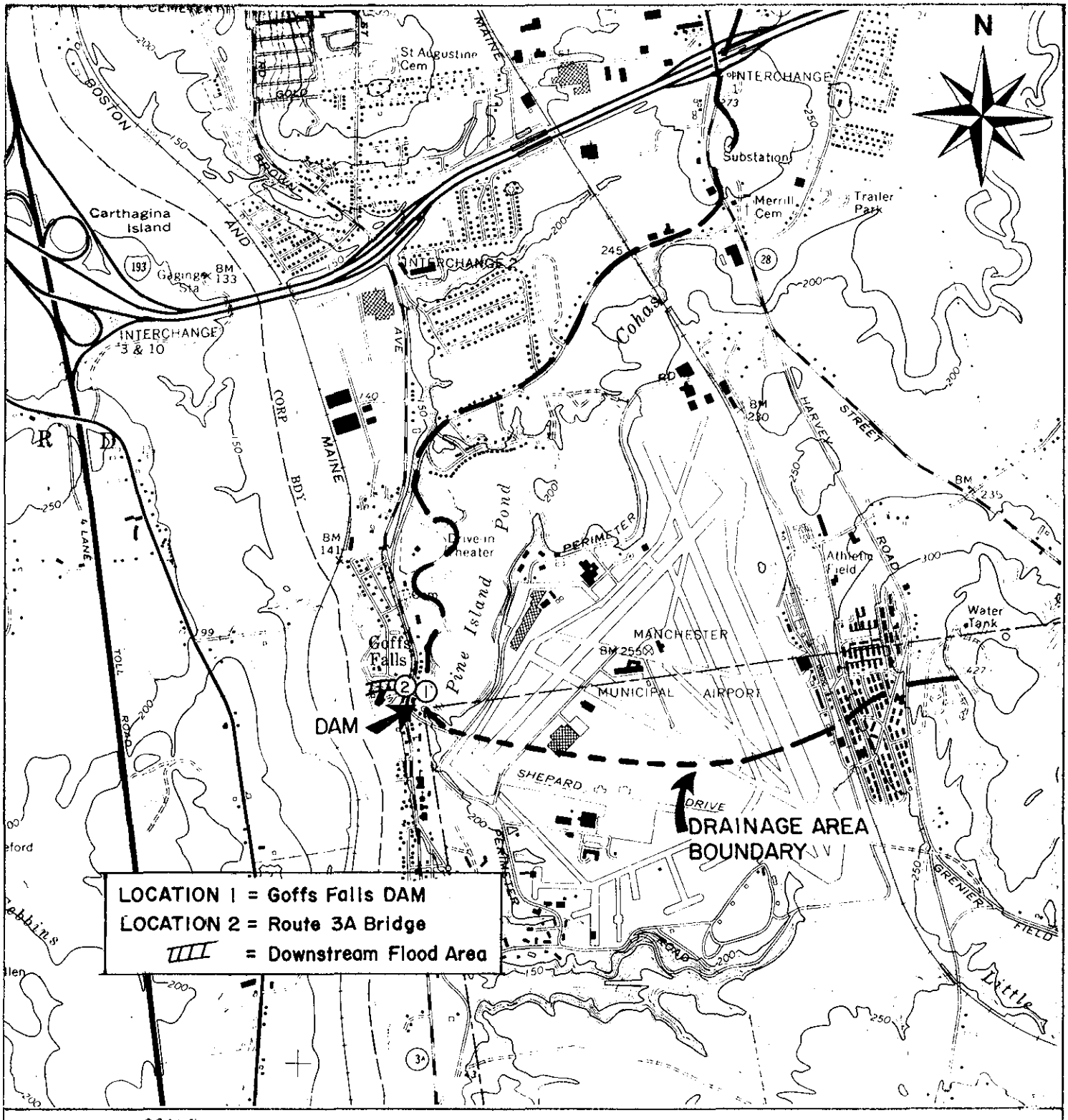
This is 3600/2280 or 158% of the spillway capacity.

Peak Test Flood pool elevation

from Head-Discharge Curve for Goffs Falls dam

$\underline{\underline{H = 6.1'}}$ at Q = 3600 cfs

The right abutment will be overtopped by 1.6'. Approximately 30 cfs will flow over the abutment.



- SCALE -

0 1000 2000 4000 (FEET)

FROM: USGS MANCHESTER NH. QUADRANGLE MAP

GOLDBERG · ZOINO & ASSOCIATES, INC.
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

FILE No. 2605

GOFFS FALLS DAM — MANCHESTER, NEW HAMPSHIRE

SCALE AS NOTED

DATE AUGUST 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS